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SPRAYING APPLES AND PEARS AGAINST FUNGI.

FEBRUARY, 1894.

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SOME FUNGUS DISEASES OF PLANTS AND THEIR TREATMENT.

It is the purpose of this bulletin to call the attention of farmers to the causes of certain losses in their crops, and the treatment by which some of them may be profitably prevented. The injuries caused to crops by insects have long been known and understood; because in most cases the insects and their methods of operation could be seen with the naked eye. But there is another class of injuries, know as blights, rusts, smuts, mildews, etc., which have not been well understood, for the reason that the nature of their cause could only be made out by the aid of the microscope. These diseases have been attributed to various causes, usually some condition of the soil or the weather, but it is now known that they are due to the growth on the affected plants of minute *parasitic* plants, which as a class are called fungi (fungus is the singular, fungi the plural).

The fungi, while being as truly plants, differ in many of their characteristics from the plants on which they grow. Most of them are very small, so as to be invisible to the naked eye, except when growing in considerable quantity. They do not possess roots, stems, leaves, and flowers like ordinary plants, but consist chiefly of minute slender threads or tubes, which grow in or upon the tissues of the diseased plants, drawing nourishment from them in something the same way that the roots of an ordinary plant extend through the soil and draw nourishment from it. It

is by robbing the tissues of their host plants of food that the fungus plants produce their injuries. Upon the threads of the fungus plants there are produced in various ways little bodies called *spores*, which correspond to the seeds of higher plants, *i. e.*, they are the means of reproduction of the fungus. The spores are usually produced in immense numbers. When mature they are easily detached, and being so light are readily distributed by the wind, just as the seeds of many weeds are scattered.

The spores under proper conditions of temperature and moisture germinate, and if they chance to be upon a suitable plant, develop into a fungus similar to the one which produced them, and thus spread the disease.

These diseases do not affect all plants indifferently, but each plant has its own peculiar enemies. Certain conditions of weather affect more or less their development, a warm, moist season being especially favorable to them. Other things being equal, thrifty plants are less liable to be attacked than the opposite.

It has long been known that the injuries of insects could be largely prevented by applying to the affected plants certain poisonous substances, such as hellebore, Paris green, London purple, etc. These substances seem to have no effect upon fungus diseases; but others have been found which have proved to be very effectual in their treatment. Among these, the most valuable are copper carbonate and copper sulphate, the latter being commonly known as blue vitriol or blue stone. They are prepared in various ways, and sprayed upon vines or trees, there coming in contact with the fungus spores which are liable to be present, and killing them.

This treatment must be considered preventive rather than curative, for in many cases after the fungus has gained an entrance to the tissues of the host plant, it is out of reach of the spray and will develop in spite of it. In the preparation of fungicides the following formulas are recommended:

BORDEAUX MIXTURE.

Blue vitriol (copper sulphate),	1 lb.
Fresh lime,	1 lb.
Water,	12 gals.
or	
Blue vitriol,	4 lbs.
Fresh lime,	4 lbs.
Water,	50 gals. or 1 barrel

Dissolve the blue vitriol in several gallons of water, say one fourth the quantity to be used, or it may first be dissolved in a smaller quantity of hot water and then several gallons of cold water added. Slake the lime and make a thin whitewash, then pour this slowly into the solution of vitriol, stirring thoroughly; then add water sufficient blue to make up the required quantity. Before using the mixture it should be strained through sacking or a sieve of some kind, with about a 1-16 in. mesh, to remove the coarser particles, which are liable to clog the nozzle of the pump.

Iron vessels should not be used in preparing any of these mixtures.

SOLUTION OF COPPER CARBONATE IN AMMONIA.

Copper carbonate,	5 oz.
Ammonia (strong),	3 to 5 pints
Water,	45 gallons

Mix the copper carbonate with about a pint of water, and then add the ammonia. If the three pints are not sufficient, add more until the carbonate is all or nearly all dissolved; then add water to make up 45 gallons or a barrel.

MODIFIED EAU CELESTE.

Blue vitriol,	4 lbs.
Sal soda (sodium carbonate),	5 lbs.
Ammonia (strong),	3 pints
Water,	45 gallons

Dissolve the blue vitriol and soda separately in two or three gallons of water; mix the two solutions, stirring thoroughly; then add the ammonia, and dilute with water

to the required amount. A solution of one half the strength of the above is recommended by some.

SIMPLE SOLUTION OF BLUE VITRIOL.

Blue vitriol,	1 lb.
Water,	25 gallons

This solution may be used for spraying trees and vines before the leaves appear, but should not be used afterwards, as it is liable to burn the foliage.

It is often desirable, especially in spraying apple trees and potatoes, to combine a remedy for insects with the remedy for fungi. Paris green and London purple may be added to the Bordeaux mixture in the proportion of one fourth lb. to fifty gallons; but these substances should never be used with the other fungicides, as the combination will burn the foliage.

There will be required for applying these solutions or mixtures a force pump, provided with a nozzle which will give a very fine spray. The finer and more powerful the spray, the more effectively, economically, and quickly can the work be done. There are many different spraying pumps manufactured, which may be found advertised in agricultural papers. Where only vines and small trees are to be sprayed, what is known as the Knapsack pump, from the fact of its being carried on the back like a knapsack, will be found very useful, especially as it can be worked by one person while the other forms require one to pump and another to direct the nozzle. The smaller force pumps, such as are used for washing windows or carriages, are to be recommended only where there is a very small amount of spraying to be done. They are seldom provided with suitable nozzles.

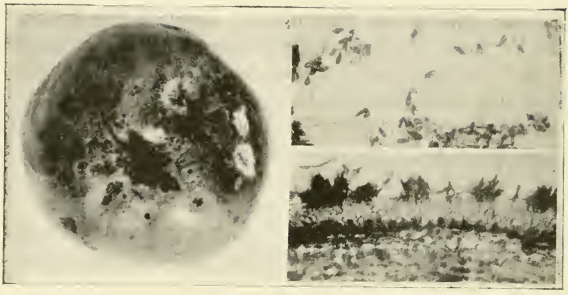
The pump which will be found most generally useful, and which costs only a moderate sum, is a strong force pump, working with a lever handle, which can be attached to the head or side of a barrel or cask. The pump should be provided with ten or twenty feet of hose and a suitable

nozzle. One of the best forms of nozzle is that known as the Vermorel. It gives a good spray and is so constructed as to be readily freed when it happens to become clogged, as it may when using the Bordeaux mixture. This form of pump is usually provided with some means for keeping the contents of the barrel stirred up; but if not, or if it does not prove to be efficient, some other means will have to be employed, as the stirring is necessary in using the Bordeaux mixture or mixtures containing Paris green or London purple. The pump should be of brass, or lined with brass, as the substances used in spraying are liable to corrode iron.

The barrel, with pump attached, can be mounted on a wheelbarrow, drag, or wagon. In spraying tall trees the nozzle and hose may be attached to a light pole. Spraying pumps may be obtained through hardware dealers, or directly of the manufacturers, who will send price-lists on application. The following firms make good pumps: W. B. Douglass, Middletown, Conn.; Field Force Pump Co., Lockport, N. Y.; Nixon Nozzle and Machine Co., Dayton, Ohio. A Knapsack pump will cost about $14.00. A force pump and barrel, as described above, will cost $10 to $12.

The chemicals for making the fungicides may be obtained of any druggist.

Certain varieties of apples and pears are subject to a fungus disease which is known as Scab. It appears in the form of black or greenish black spots on the surface of the fruit and leaves. The spots are round in outline, from a sixteenth to half an inch in diameter, often running together, forming large irregular patches, and sometimes almost entirely covering the fruit, which is also frequently one-sided and more or less cracked. When examined under the microscope the spots are found to be a mass of closely interwoven fungus tissue, growing on the skin of the fruit and sending up a multitude of little stalks, on the tops of which grow elongated oval bodies—the spores or seed of the fungus plant. These, when broken off and carried to a



[On the left of the cut is shown a scabbed apple. The lower half on the right shows a perpendicular section through one of the scab spots magnified about 100 diameters. The upper half shows some of the detached spores similarly magnified.]

healthy fruit or leaf, or to a healthy part of the one on which they grew, germinate and produce a new spot. The Scab on apples and pears is considered to be produced by two different species of the same fungus, which are so nearly alike that one description answers for both.

The Scab is frequently the cause of great loss. Some varieties suffer more than others. Among apples the Fameuse or Snow apple seems to be especially liable to scab, but many other varieties suffer more or less. Among pears in this vicinity the Flemish Beauty and Sheldon are most affected, but the Seckel, Beurre d'Anjou, Lawrence, and Swan's Orange are very liable to be injured by the disease. The scabbing and cracking can be prevented to a great extent by spraying the trees several times with one of the above described fungicides.

It is probable that many spores of the scab fungus remain on the trees over winter, and are ready to infect the foliage and fruit as soon as they make their appearance in the spring; hence the first application of the fungicide should be made before the buds open. At this time the simple solution of blue vitriol may be used, but not afterwards. After the blossoms have fallen, the trees should be

sprayed again, and then once or twice more at an interval of ten days or a fortnight. For the sprayings after the first, we should at present give the preference to the Bordeaux Mixture, although the other fungicides have given good satisfaction in other places. This treatment will cost about twenty or twenty-five cents per tree per year.

Another fungus disease attacking apples and pears, especially the latter, greatly affects the appearance of the fruit, if it does not injure it otherwise. The fruit on which it grows has a dirty, sooty appearance, as though it had been exposed to the action of smoke. The fungus grows on the skin, not in well-defined spots like the Scab, but diffused over the surface. Spraying appears to be very effective against this trouble. For summary of experiments in the treatment of the above diseases, see page 10.

A third disease of the pear, which is much harder to deal with, is called the Blight. It is characterized by the blackening of the leaves and twigs, rapidly followed by their death. This may be so serious as to soon kill the whole tree. The Blight is caused by the growth in the twigs and leaves of a very minute parasitic plant, belonging to the class known as Bacteria. It is probably due to the fact that this fungus develops almost entirely inside the leaves and branches, that spraying seems to be of little use. About the only treatment that can be recommended at present is to cut off and burn the affected parts as soon as the disease makes its appearance. The twigs should be cut off at some distance below the affected spot, so as to ensure the entire removal of the germs of the disease.

The plum and cherry are affected by two serious fungus diseases, viz., the Black Knot and the Rot. The Black Knot is caused by a fungus which in some way gets inside the twigs and branches, where it develops causing the parts to swell and finally to crack open in the spring. Soon the cracked surface becomes covered with a dark greenish growth, which bears a crop of spores; later the black warty

surface develops, containing another crop of spores. Spraying has not been found to be of much use in treating this disease. The best that can be done is to cut out and destroy the diseased parts, painting the wounds to prevent the entrance of fresh spores of the fungus. As cultivated trees may be infected from the wild ones, the latter also should be taken care of. All farmers should unite in trying to stamp out this disease.

The Rot affects the fruit, and sometimes the leaves and young twigs. On the fruit it appears as a brown spot, which soon spreads, often over the whole surface of the fruit. The diseased surface soon becomes covered with many little ash-gray spots or tufts, which consist of spore-stalks bearing innumerable spores. Spraying as yet has not proven very satisfactory as a preventative of the Rot. The diseased fruit should be thoroughly removed as fast as it appears, and destroyed, and it would be well to spray the trees in the spring, before the buds open, with the simple solution of blue vitriol.

It is a rule which may be held as applying to all fungus diseases, that all diseased parts should be carefully collected and destroyed by burning.

The Blight or Rust of potatoes is a disease which can be profitably treated by spraying. A bulletin on this subject will appear later.

SUMMARY OF EXPERIMENTS IN THE TREATMENT OF THE SCABBING AND CRACKING OF APPLES AND PEARS.

The extent of these experiments has been limited by the difficulty of finding suitable trees in the vicinity of the experiment station. In 1892 a Fameuse apple-tree was sprayed with Bordeaux mixture on June 8, 16, 29, July 9, and August 5. Another tree of the same variety was left unsprayed for comparison. The apples were gathered October 7, with the following result:

	Unsprayed.	Sprayed.
Practically free from scab	29 per cent.	65 per cent.
Slightly scabbed	48 "	24 "
Badly "	23 "	11 "

The Bordeaux mixture used in this case was made according to the original formula—6 lbs. blue vitriol and 4 lbs. lime to 22 gallons of water. This has been found to be much stronger than is necessary. Also, four sprayings will usually be found sufficient.

The same season a Flemish Beauty pear tree was sprayed with Bordeaux mixture on June 1, 8, 16, 29, July 9, and August 5. Another tree was left unsprayed as a check. The pears were gathered September 21, and showed the following:

	Unsprayed.	Sprayed.
1st quality	5 per cent.	70 per cent
2d "	12 "	28 "
3d "	83 "	2 "

In this case the Bordeaux contained one pound of blue vitriol to eight gallons of water. For the last spraying, August 5, the solution of copper carbonate was used instead. Here, also, four sprayings would probably have answered.

The following experiments were made in 1893 in orchards at Durham and Dover:

In one orchard five Sheldon pear trees were sprayed May 15, just before the blossoms opened; June 1, just after the blossoms had fallen; and on June 16 and 28. On two of the trees Bordeaux mixture, of the strength of 1 lb. each blue vitriol and lime to 8 gallons of water, was used; on the others, of the strength of 1 to 12. However, owing to an oversight, the pears when gathered were not kept separate, so that the comparative effect of the two strengths could not be determined. Two trees were left unsprayed as checks.

When the pears were gathered they were examined and counted with the following result:

	Unsprayed.	Sprayed.
1st quality	3 per cent.	58 per cent.
2d "	35 "	30 "
3d "	62 "	12 "

On account of the small number of pears on these trees the above result should be taken as an indication rather than as conclusive evidence.

In another orchard on the same dates as the above the following sprayings were made:

A. Three Sheldons unsprayed as checks.

B. One Sheldon sprayed with Bordeaux mixture, containing one pound each blue vitriol and lime to 12 gallons water.

C. Two Sheldons, Bordeaux mixture 1–16.

D. Two Sheldons, Modified Eau Celeste.

E. Three Sheldons, Ammoniacal Solution Copper Carbonate.

When gathered the following was found to be the result:

	A.	B.	C.	D.	E.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1st quality . . .	29	67	76	52	32
2d " . . .	42	30	16	29	38
3d " . . .	29	3	8	19	30

Four Lawrence pear trees were sprayed with Bordeaux mixture, and one left unsprayed. The sprayings were made May 20, June 10, 21, and July 1.

The pears when gathered showed the following:

	Unsprayed.	Sprayed.
1st quality	57 per cent	55 per cent.
2d "	43 "	45 "
3d "	0 "	0 "

These figures do not show the full effect of the spraying. From the statements of the owner it was inferred that the pears were subject to the attacks of some fungus disease, but not being familiar with the Lawrence we did not know just what one. The sequel showed that there were two, one the ordinary Scab and a second fungus described on page 9. While the pears from the unsprayed tree classed as first quality were of good size and such as are frequently seen in the market, the majority of them were more or less badly disfigured by this fungus. On the unsprayed tree 88 per cent. of the pears were affected with it, while on the sprayed trees less than 1 per cent. were affected. So far as our observation goes the Scab does not seem to affect the

Lawrence so seriously as it does some other varieties, and very few of the pears on the unsprayed tree were badly damaged by it. But 63 per cent. showed more or less of it, while only 20 per cent. of the sprayed were at all scabby.

The following trees which were sprayed were in a sense isolated, that is to say, there were no other trees of the same variety in the immediate vicinity to serve as checks.

A Flemish Beauty tree was sprayed May 15, June 1, 16, and 28, with Bordeaux mixture, one pound each blue vitriol and lime to twelve gallons water. The result was,—

1st quality	58 per cent.
2d "	38 "
3d "	4 "

It is safe, we think, to say that in this region untreated Flemish Beauty trees will not average to yield over 10 or 15 per cent. of first quality or marketable pears.

Another Flemish Beauty was sprayed June 2, 15, 21, and July 1 with Bordeaux mixture, one pound each blue vitriol and lime to sixteen gallons of water. The result was,—

1st quality	27 per cent.
2d "	36 "
3d "	37 "

It seems probable that the less favorable result in this case was due to the fact that the spraying was begun late and a weaker form of the remedy was used. The owner says, however, that this yield is better than that of previous years. Another tree, which was supposed to be a Flemish Beauty but which proved to be a Louise Bonne, was sprayed on the same dates as the preceding tree with Ammoniacal Solution of Copper Carbonate. The fruit when gathered showed,—

1st quality	46 per cent.
2d "	51 "
3d "	3 "

The gentleman who occupied the place says that last year not more than 25 per cent. of the pears were of the first quality, owing to the Scab.

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